

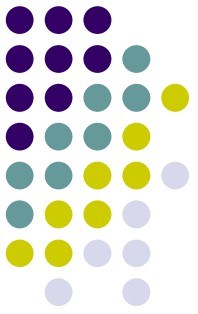
Collaborative Ontology Development in Protégé

Tania Tudorache
Stanford University

- Ontolog forum invited talk-

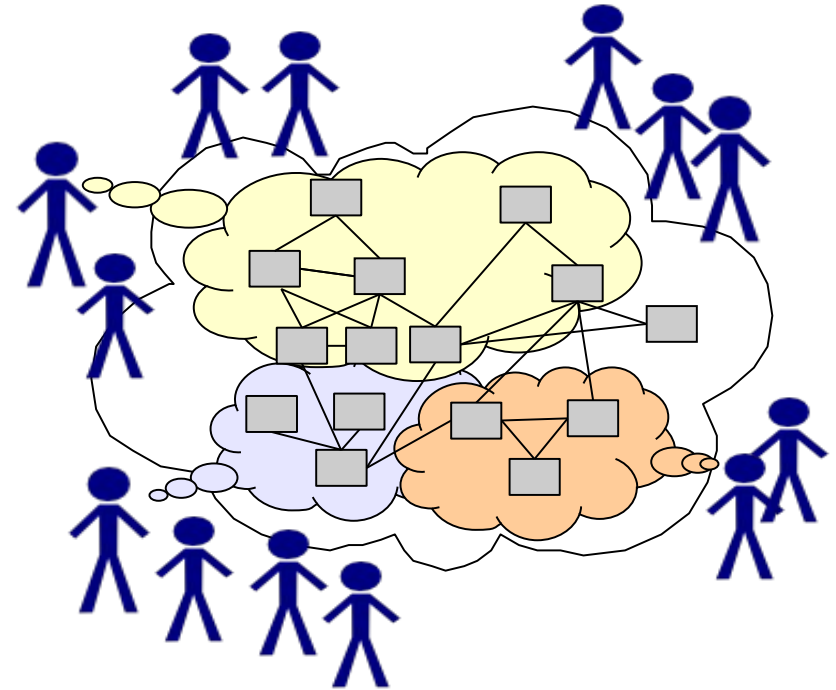
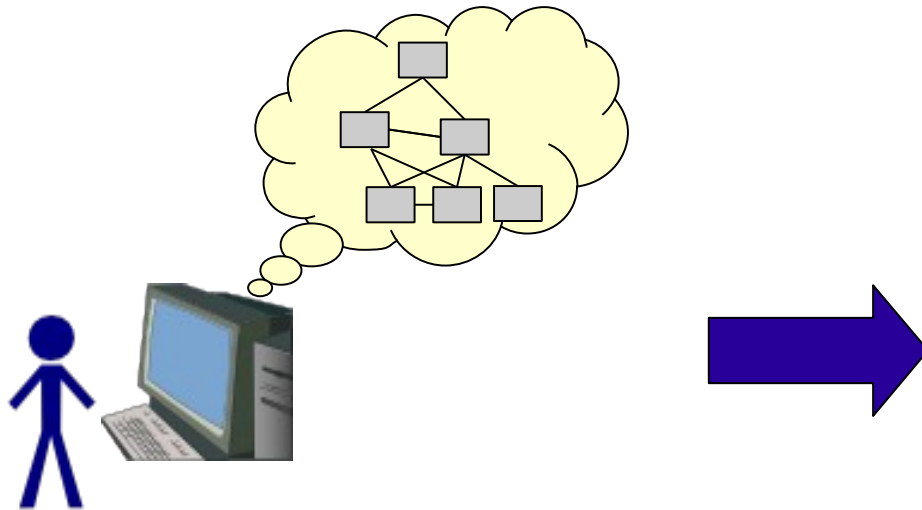
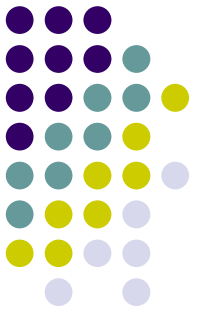
04. October 2007

Outline



- Introduction and Background
- Tools for collaborative knowledge development
- Use cases
- Workflows
- Collaborative Protégé
- Future directions

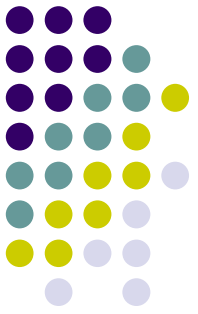
Evolution of ontology development



- Single ontology developer
- Small size ontologies
- Desktop applications

- Community of ontology developers
- Large ontologies
- Web applications

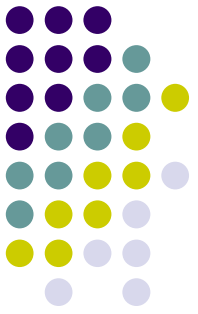
Collaborative ontology development



Two or more people interact and exchange knowledge to build a common ontology in pursuit of a shared, collective, bounded goal*

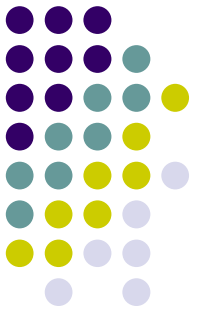
- Interaction may be indirect, but required
- Argumentation as a common interaction means
- Simple contribution not enough
- Bounded goal: beginning and end
- Collaborators may have individual goals

Outline



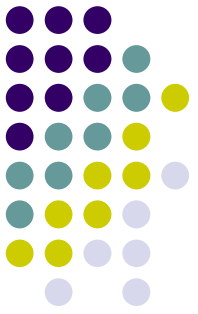
- Introduction and Background
- **Tools for collaborative knowledge development**
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Requirements



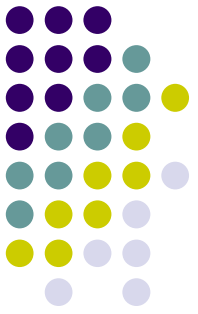
- Annotations of ontology components and changes
 - Marginal notes
 - Discussion threads
- Workflow support
 - Change proposals and voting
 - Rights management
 - Access privileges
- Views on the data
- Ways to establish trust, credibility
- Ratings and voting
- Comments and provenance of ratings and votes

Requirements (cont)



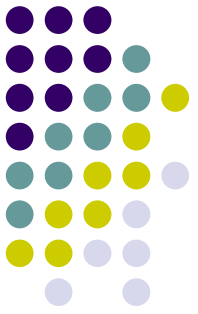
- A Web interface rather than an applet or an application
- Change history for a concept
- Ability to inform the user if something they posted was modified by someone else
- Undo and rollback based on change history
- Ability to query an old version through the vocabulary of the new one
- API access to changes; printed summary of changes
- Metrics attached to a concept

Tools for collaborative knowledge development



- Semantic wikis
 - *Semantic MediaWiki, BoWiki, etc.*
- Annotation of Web resources, tagging, bookmarks
 - *BibSonomy, SOLBOLEO*
- Ontology editors
 - *Collaborative Protégé, OntoWiki, Hozo*
- Domain-specific collaboration tools
 - *SWAN, Knewco, CBioC*

The CKC 2007 Challenge*

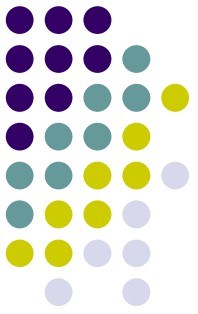


- At the Workshop on Social and Collaborative Construction of Structured Knowledge, Banff, Canada
- Goal: Find out what is the state of the art for the tools for collaborative construction of structured knowledge
- Get users to try out different tools
- Learn what users expect from such tools, what works and what doesn't
- It was not an evaluation of the tools themselves
- **Tech Report** available with challenge results

* <http://km.aifb.uni-karlsruhe.de/ws/ckc2007/challenge.html>

The CKC 2007 Challenge

Participating tools

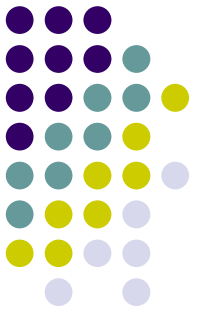


- [BibSonomy](#) (University of Kassel, Germany)
- [Collaborative Protégé](#) (Stanford University, US)
- [DBin](#) (Universita Politecnica delle Marche, Italy)
- [Hozo](#) (University of Osaka, Japan)
- [OntoWiki](#) (University of Leipzig, Germany)
- [SOBOLEO](#) (Forschungszentrum Informatik, FZI, Germany)

Different capabilities and focus

The CKC 2007 Challenge

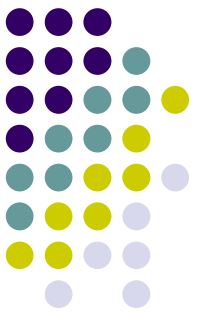
Range of tools



- Annotation of Web resources, tagging, bookmarks
 - *BibSonomy*
 - *SOBOLEO*
- Ontology editors
 - *Collaborative Protégé*
 - *OntoWiki*
 - *Hozo*
- Tools with discussion and rating facilities
 - *Collaborative Protégé*
 - *DBin*

The CKC 2007 Challenge

Popular features

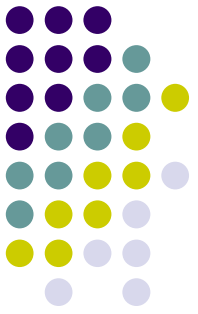


BibSonomy	postBookmark and postPublication buttons in a Browser; Upload to EndNote
Collaborative Protégé	Discussion, voting, chat Stable tool
DBin	Customizable UI
Hozo	Visualization
OntoWiki	Maps Ratings
SOBOLEO	Ease of use

See more results in the [Tech Report](#)

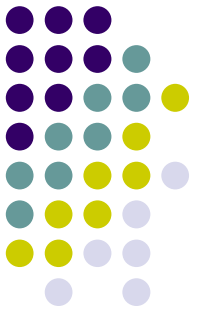
The CKC 2007 Challenge

Discussions



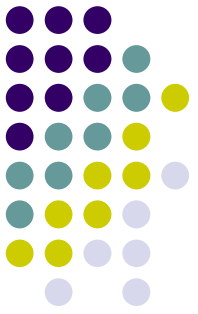
- Personal vs shared space
 - BibSonomy kept everyone's personal space separate
 - Other tools had everyone editing in the same shared space
 - Which model is more appropriate for ontology development?
- Can we even develop ontologies collaboratively?
 - *"I also think that collaborative ontology building could become very messy with a non-trivial user base; probably it would get on my nerves when people start shoving "my" concepts around."*
- What level of expressive power is appropriate?
 - Not supporting advanced OWL constraints -- is this a limitation?
- Collaborative workflows to achieve consensus

Outline



- Introduction and Background
- Tools for collaborative knowledge development
- **Use cases**
- Workflows
- Collaborative Protégé
- Future directions

Use cases



I. Ontology for Hospital Enterprise Architecture

- Perot Systems

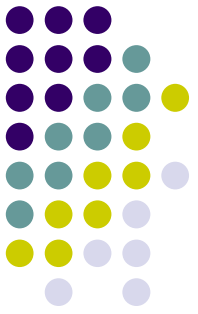
II. National Cancer Institute (NCI) Thesaurus

- NCI Center for Bioinformatics

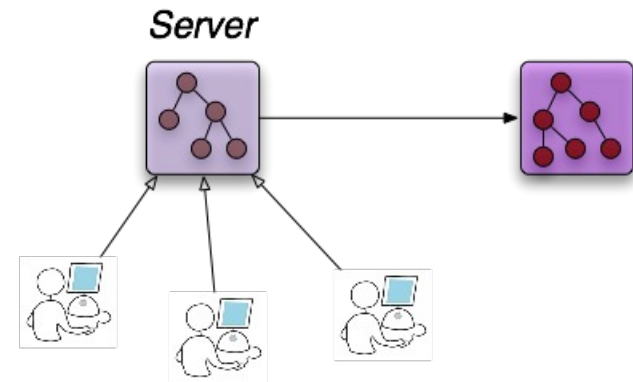
III. Open Biomedical Ontologies (OBO)

IV. International Classification of Diseases (ICD-10)

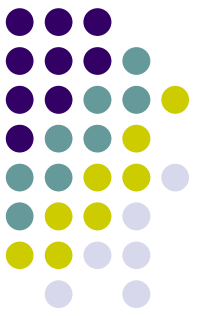
Case I: Multi-client editing



- *Multiple users editing the same ontology at the same time*
- *All changes are seen immediately*
- *No conflict resolution*

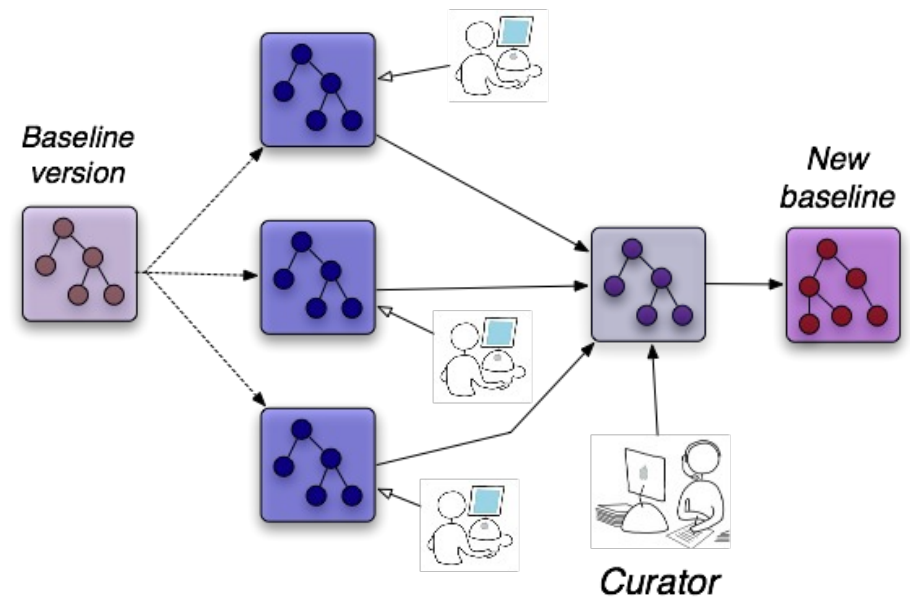


Case II: Parallel Editing, Curation

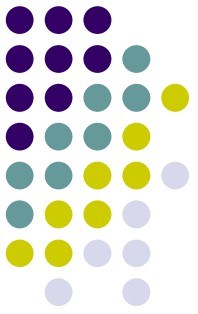


 *National Cancer Institute*

- *Changes are not immediately visible*
- *Need to merge versions and resolve conflicts*
- *Need to accept and reject changes*

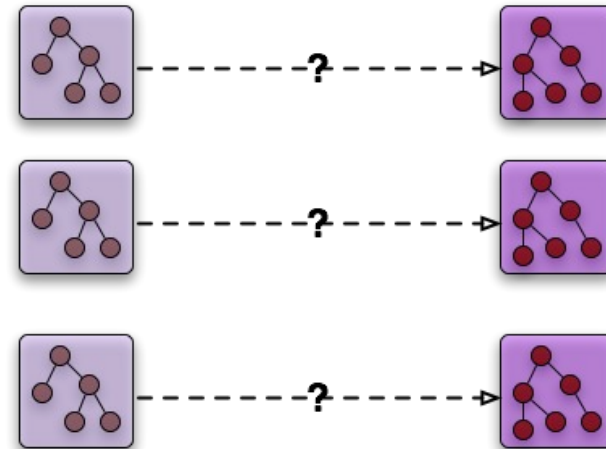


Case III: Version Repository

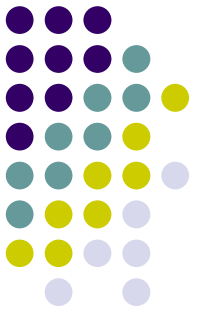


Open Biomedical Ontologies

- *Ontologies developed by different tools in different languages*
- *Usually no record of changes*
- *No record of version compatibility*

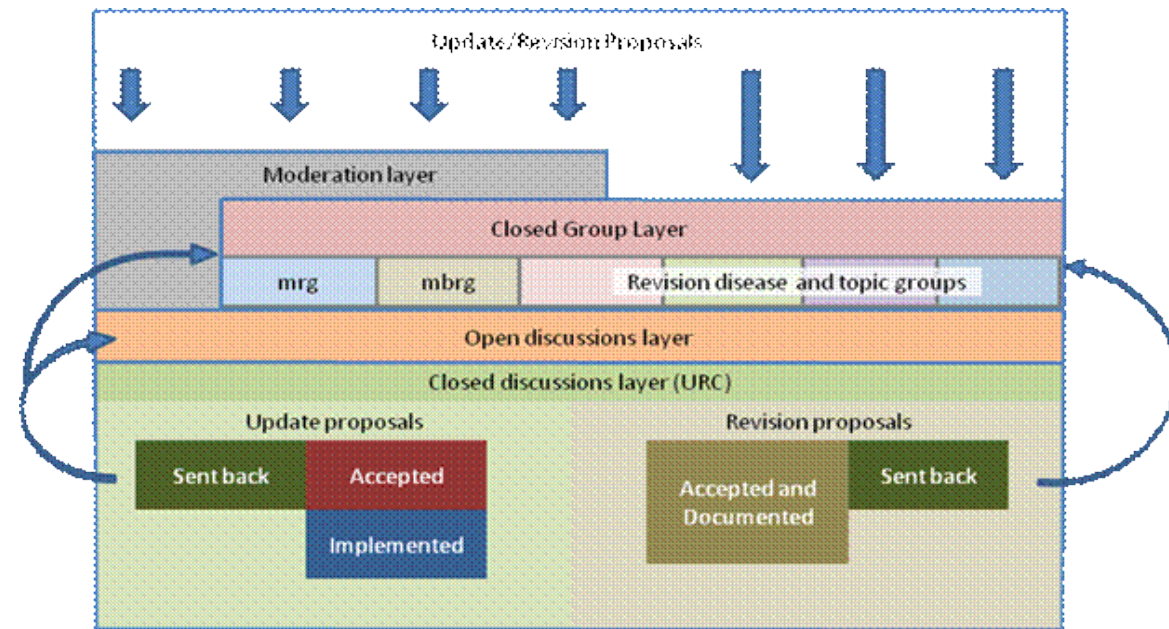


Case IV: Enforced workflow

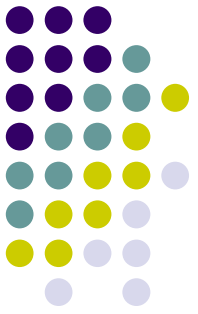


International Classification of Diseases (ICD-10)

- *Well-defined workflow*
- *Enforced by application*
- *Moderators*
- *Discussion*
- *Voting*

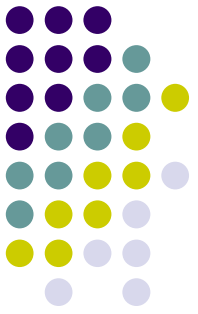


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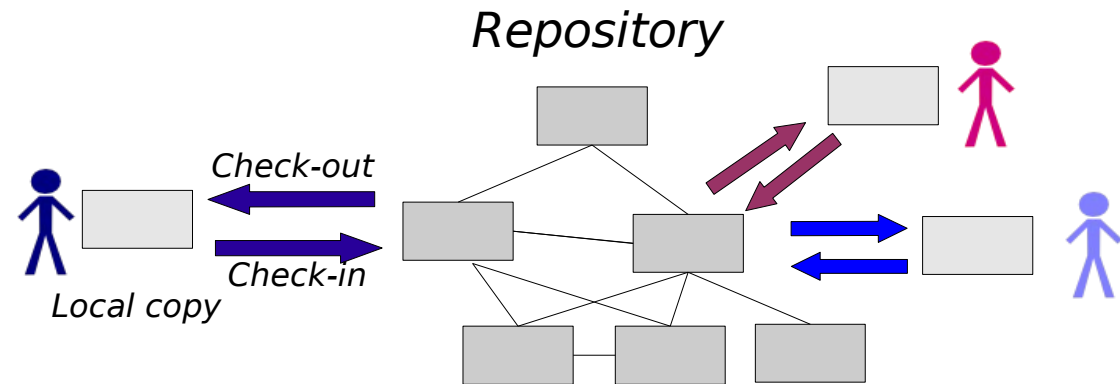
Workflow aspects of collaborative development



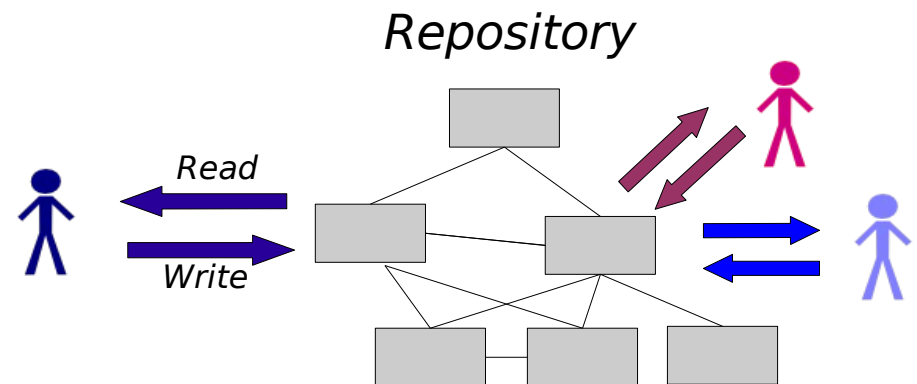
- Versioning
- Simultaneous vs. concurrent development
- Controlled vs. not controlled content
- Access rights and role groups

Versioning

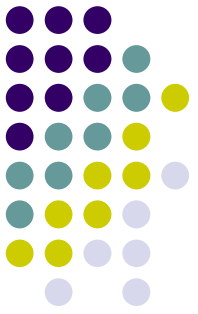
- **File versioning model (CVS, SVN)**
 - check-out and check-in parts of the ontology from a repository
 - lock the checked out part
 - effort at merging changes back in



- **Simultaneous access**
 - users edit the same ontology
 - effort at ensuring atomicity of operations

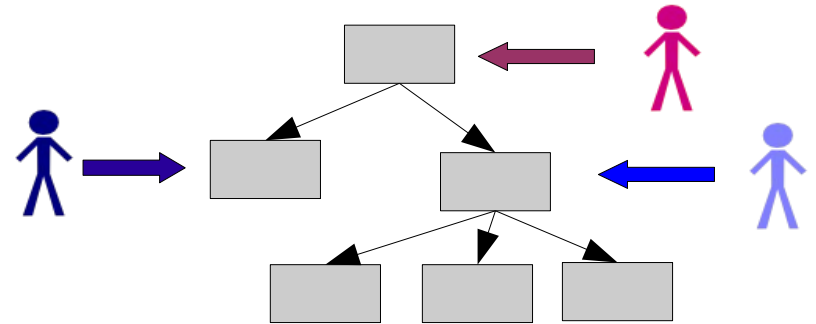


Simultaneous vs. concurrent development



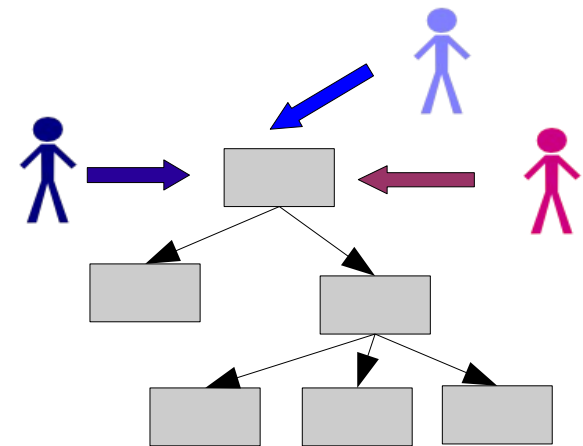
- **Concurrent model:**

- Split development task in subtasks
- Each subtask solved by one group
- Integrate solutions at the end
- Effort at the end



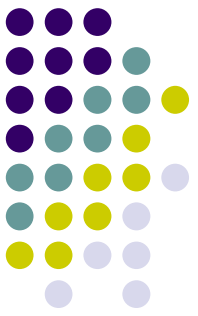
- **Simultaneous model:**

- Everybody solves the same task (maybe at the same time)
- Effort throughout the development



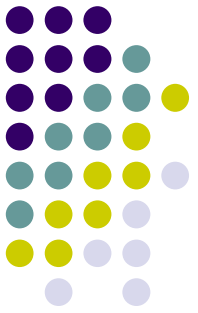
- **Hybrid**

Controlled vs. not controlled content

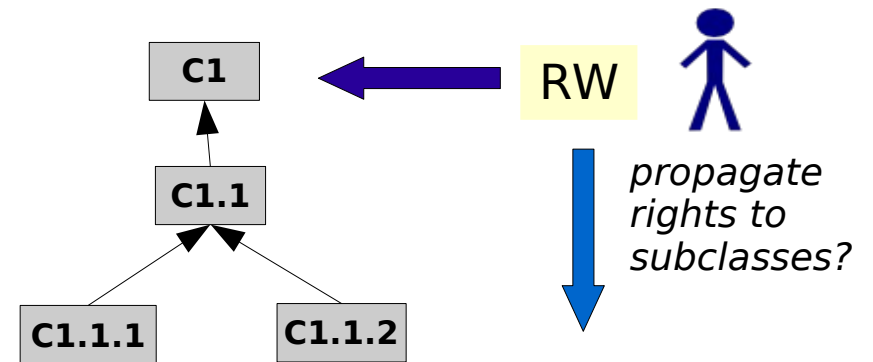


- No content control
 - Anybody can edit anything at any time
 - Similar to shared tagging in different Internet applications
 - Hard to converge
- Wiki style
 - Anybody can edit anything at any time
 - Wiki “gardeners” to do content clean up
- Accept/reject changes (NCI)
 - Anybody can edit anything at any time
 - Authority that accepts or rejects changes
- Enforced workflow (ICD10)
 - Well defined workflow enforced by the application, e.g. proposals, voting
 - Easier to converge

Access rights and role groups



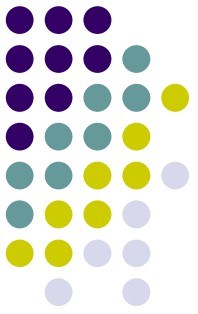
- Different access rights:
 - read
 - write (create, delete, modify)
- Different granularities:
 - on the ontology level
 - on the subtree level
 - on the ontology element level (class, property, individual)
- Need algorithms for computing the access rights for a certain component at a certain time
- Access rights depend on the language semantics -> maybe need inference to compute the actual access rights on an ontology component



RW RW ∅

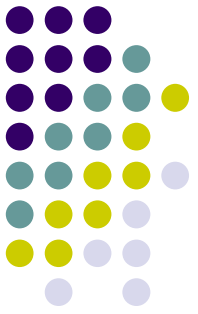
Pizza hasTopping some **PizzaTopping**

Outline



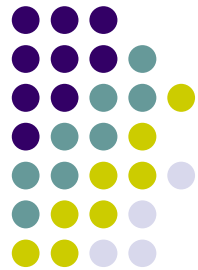
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- **Collaborative Protégé**
- Future directions

Collaborative Protégé Functionalities



- Extension of existing Protégé system
- Support for:
 - annotating ontology components and changes in the ontology
 - discussion threads
 - proposals and voting
 - searching and filtering
 - defining users, groups, policies
- Works in Protégé OWL and Frames
- Available in multi-user and stand-alone modes
- Distributed with Protégé installation

Collaborative Protégé GUI



CKC2007 Protégé 3.3 beta (rmi://smi-protege.Stanford.EDU/CKC2007)

Java Applet Window

File Edit Project Window Help

Classes Slots Instances

CLASS BROWSER

For Project: ●

Class Hier

- :THING
- :SYSTEM-CLASS
- Organization
 - Research_institute
 - University
- Person
- Publication
- Topic
- Workshop

CLASS EDITOR

For Class: ● Publication (instance of :STANDARD-CLASS)

Name: Publication

Documentation:

Role: Concrete

Name	Cardinality	Type
accepted-in	single	Instance of Workshop
author	multiple	Instance of Person
url	single	String

Superclasses

- :THING

No other users

Collaborative Panel

Collaborative Tabs

Annotations

All (Ann. & Chg.) Discussion Threads Search Chat

Annotations Changes

Filter By author... Go

Annotations on Publication

Comment

- (TestUser1 04/16/2007 16:12:30 PDT): I think we should add subclasses to Publications. Are
- ✓ (TestUser2 04/16/2007 16:14:24 PDT): Good idea!
- (tania 04/16/2007 16:46:43 PDT): Should we add a "cited-in" property to Publication?

Annotations

Annotation body

INSTANCE EDITOR

For Instance: ◆ (TestUser1 04/16/2007 16:12:30 PDT): I think we should add subcla...

Subject

Add subclasses of Publication

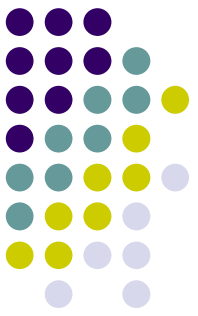
Description

I think we should add subclasses to Publications. Are there any standard publication types that we could use?

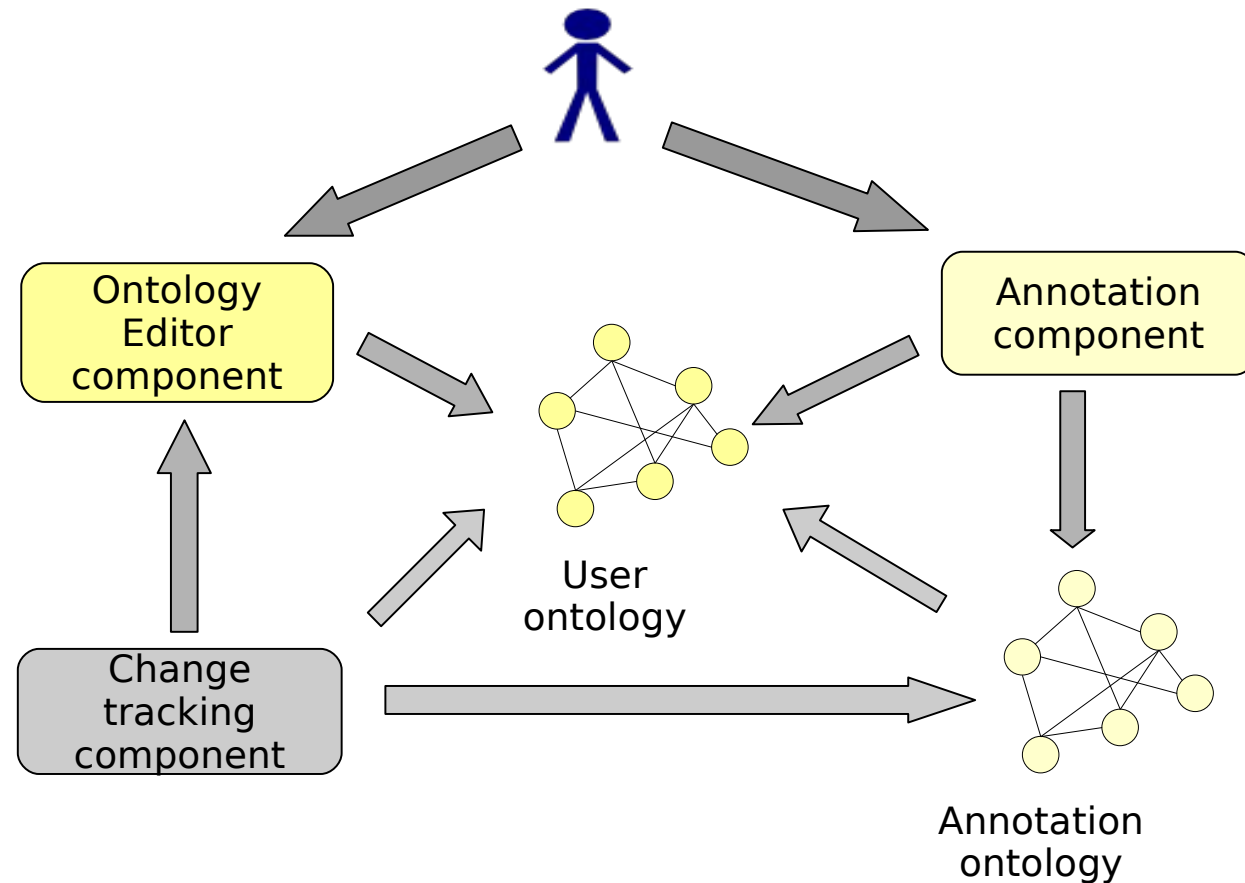
has annotations

Annotation details

Interactions in Collaborative Protégé



- Ontology editor component:
 - basic ontology editing functionalities
- Annotation component:
 - user ontology is annotated with annotation instances from the Annotation ontology
- Change tracking component:
 - changes are stored as instance of the Annotation ontology



Annotations & Changes Ontology



newspaper Protégé 3.3 beta (file:/work/protége/projects/collab/newspaper.pprj, Protégé Files (.pont and .pins))

File Edit Project Window Help

Classes Slots Forms Instances ChangesKBViewTab

CLASS BROWSER

For Project: ● annotation_newspaper

Class Hierarchy

- :THING
 - :SYSTEM-CLASS
 - ▼ ● AnnotatableThing
 - ▼ ● Annotation
 - Advice (17)
 - Comment (50)
 - Example (3)
 - Explanation (5)
 - ▶ ● Proposal
 - Question (1)
 - SeeAlso
 - ▼ ● Vote
 - AgreeDisagreeVote (2)
 - FiveStarsVote (6)
 - ▼ ● Change
 - ▶ ● Class_Change
 - Composite_Change (54)
 - ▶ ● Created_Change
 - ▶ ● Deleted_Change
 - ▶ ● Individual_Change
 - Name_Changed (21)
 - ▶ ● Property_Change
 - ▼ ● Ontology_Component
 - Ontology_Class (33)
 - Ontology_Individual (6)
 - Ontology_Property (18)
 - Timestamp (282)

INSTANCE BROWSER

For Class: ● Question

multiple slots

stania 04/20/2007 11:34:33 PDT: Why is the sky blue?

CLASS EDITOR

For Class: ● Question (instance of :STANDARD-CLASS)

Name: Question

Documentation: A class of Annotations representing questions about the content

Role: Concrete ●

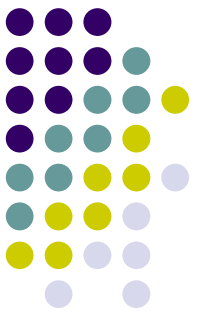
Template Slots

Name	Cardinal...	Type	
annotates	multiple	Instance of Annotatabl...	inverse-slot=ass
associatedAnnotati...	multiple	Instance of Annotation	inverse-slot=ann
author	single	String	
body	single	String	
context	single	String	
created	single	Instance of Timestamp	
modified	single	Instance of Timestamp	
related	single	String	

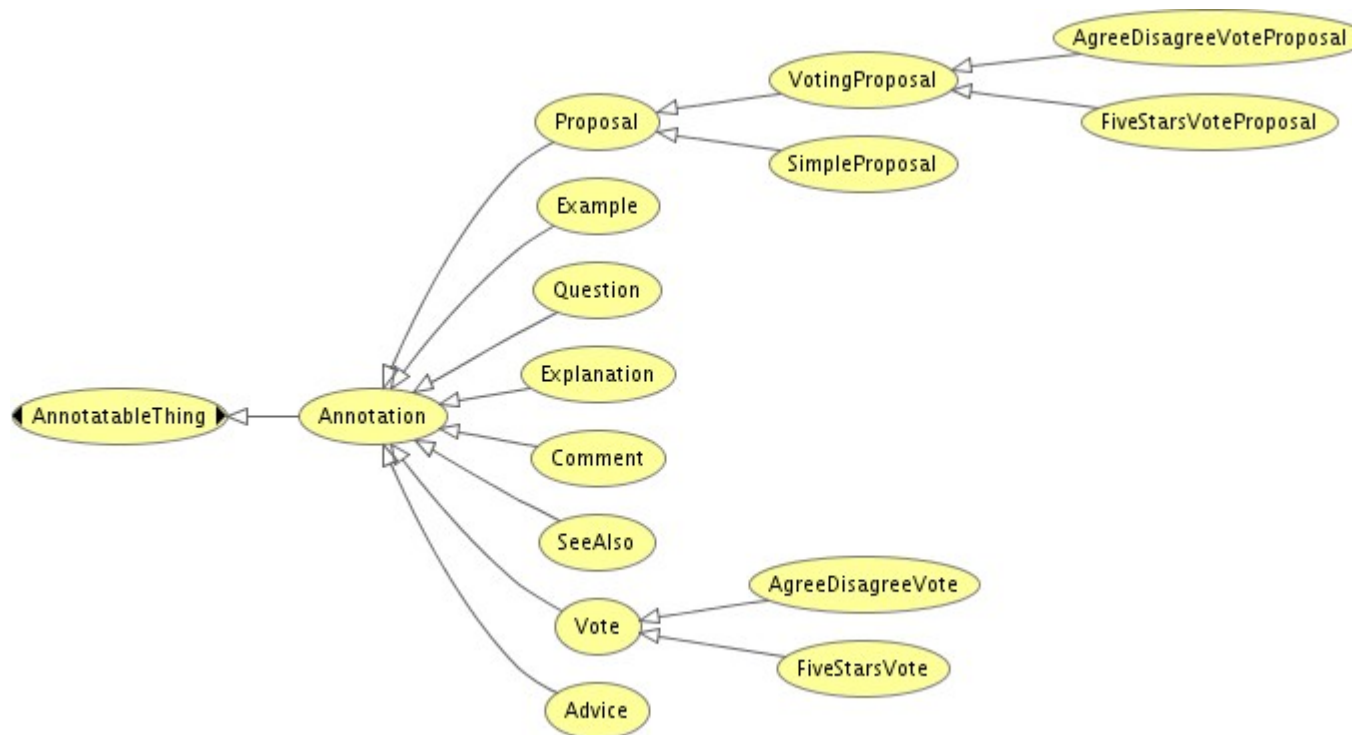
Types

Annotation ontology

Annotation class

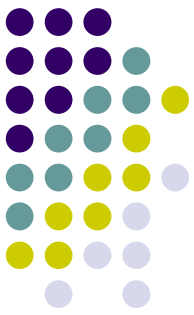


- Subclasses of class Annotation provide the annotation types that are available through the Collaborative Protégé UI.

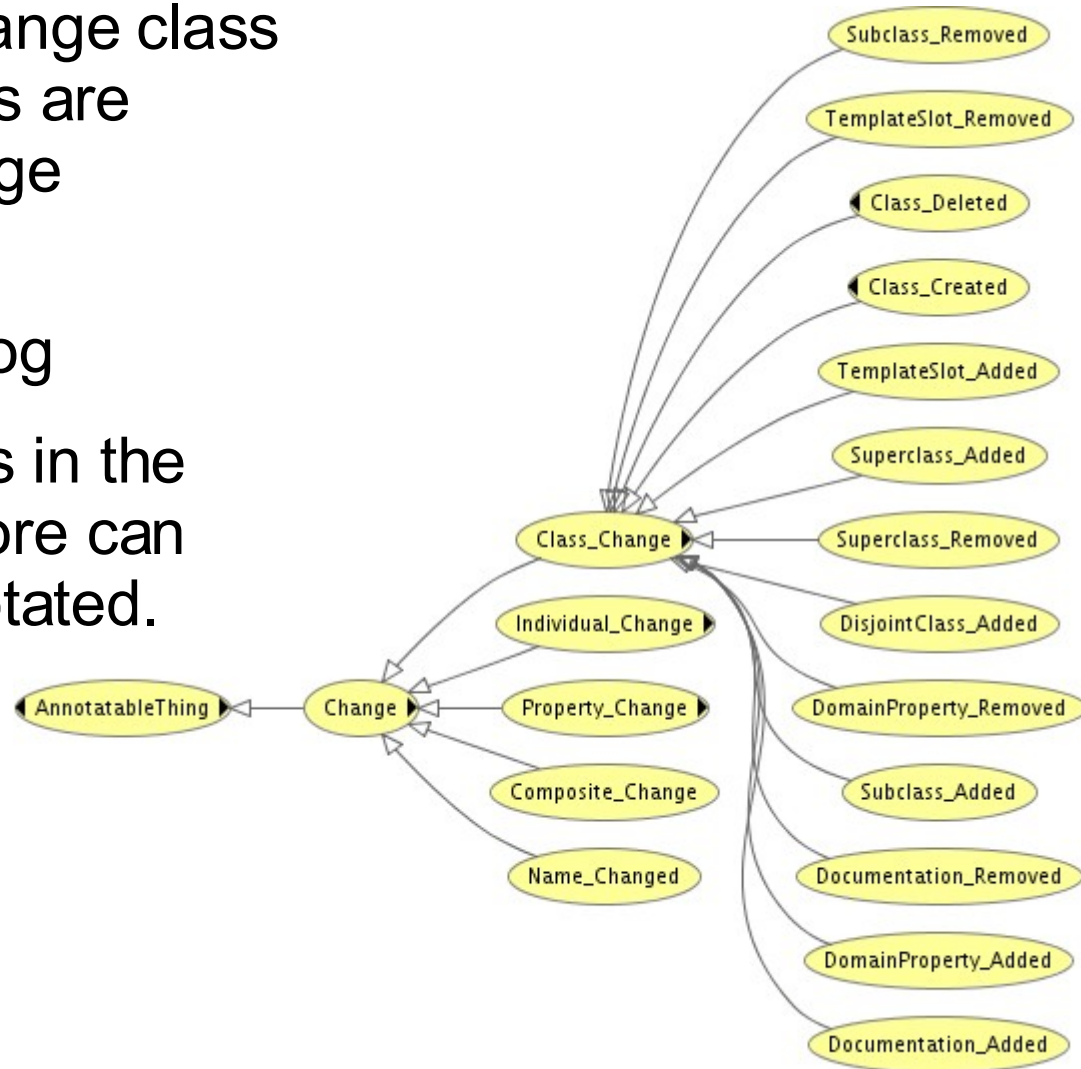


Annotation ontology

Change class

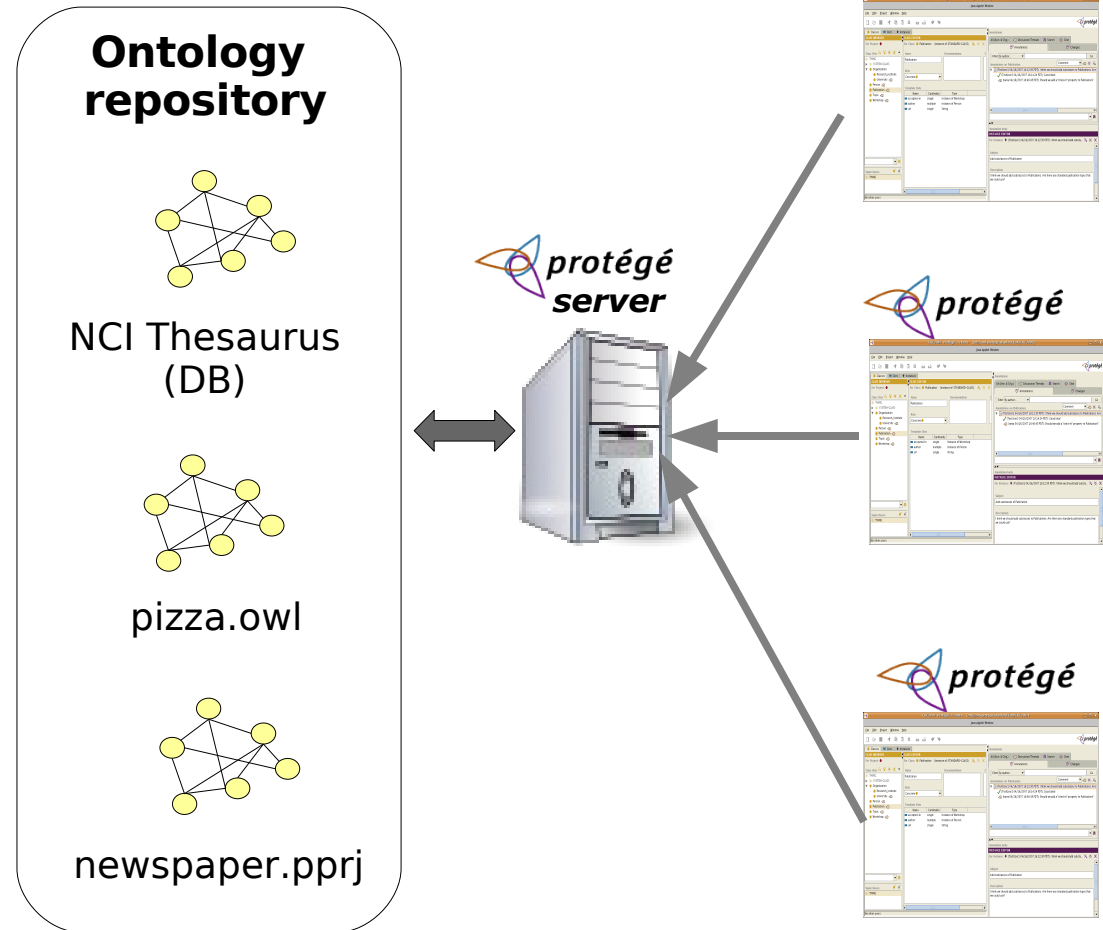


- Instances of the Change class and of its subclasses are created by the change tracking component
- Structured change log
- Changes are objects in the ontology and therefore can themselves be annotated.

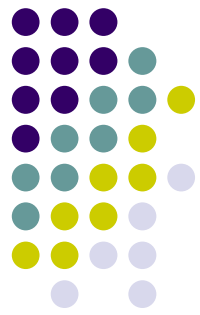


Multi-user Protégé

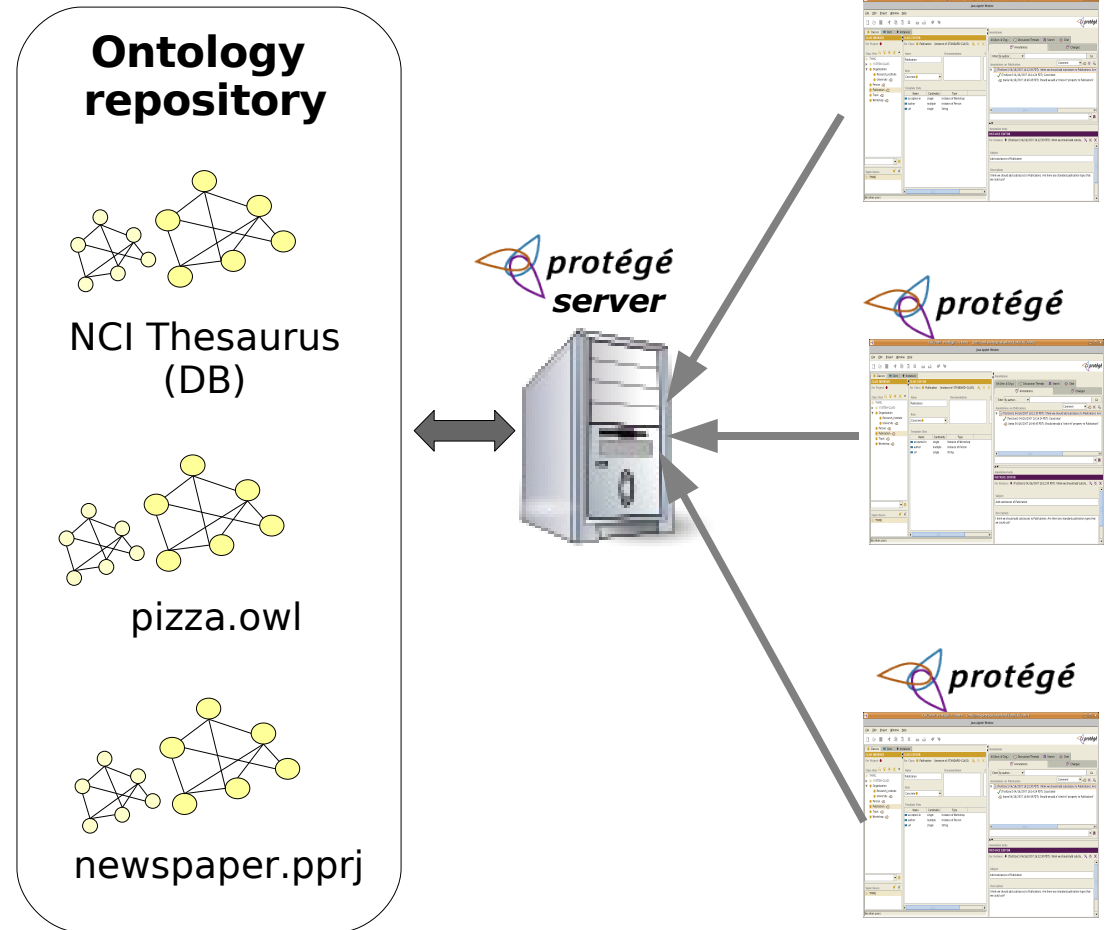
- Multiple Protégé clients may connect to a Protégé server and edit the same ontology at the same time
- All changes of a client are seen immediately by all other clients
- Configuration of users, groups, policies



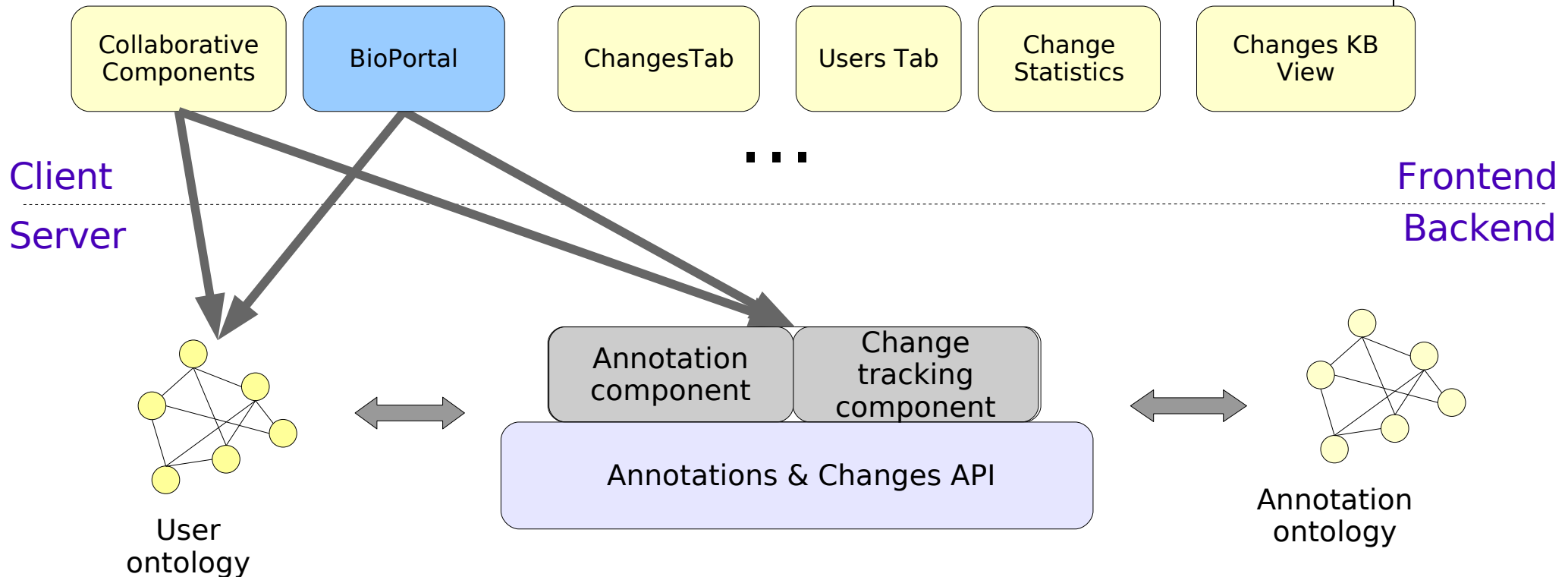
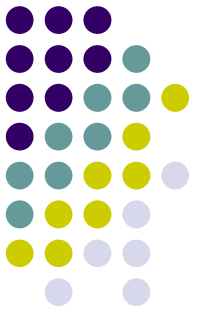
Collaborative Protégé in multi-user mode



- To each ontology on the server we attach an annotation ontology
- All annotations made by a user are seen immediately by other users



Client-server architecture



Applications and components on the client side use the common Changes & Annotations API to manipulate the annotations and changes associated to an ontology.

Annotations Tab



CKC2007 Protégé 3.3 beta (rmi://smi-protege.Stanford.EDU/CKC2007)

Java Applet Window

File Edit Project Window Help

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CLASS BROWSER

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- Topic
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For Class: ● Publication (instance of :STANDARD-CLASS)

Name: Publication

Documentation:

Role: Concrete ●

Template Slots

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author	multiple	Instance of Person
url	single	String

Annotations

All (Ann. & Chg.) Discussion Threads Search Chat

Annotations

Filter By author... Go

Annotations on Publication

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Annotation body

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For Instance: ◆ (TestUser1 04/16/2007 16:12:30 PDT): I think we should add subcla...

Subject: Add subclasses of Publication

Description: I think we should add subclasses to Publications. Are there any standard publication types that we could use?

Annotation details

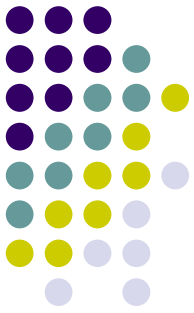
Filtering

Annotation types

Search

No other users

Annotations Tab (cont)



- Annotations are linked to a specific ontology component
- Different types of annotations
- Users may annotate:
 - classes
 - slots (properties)
 - instances (individuals)
- Annotations may be filtered and search based on different criteria

The screenshot displays three overlapping panels from an ontology browser:

- CLASS BROWSER:** Shows a class hierarchy for a project. The 'Person' class is highlighted. The hierarchy includes Organization (Research_institute, University, Research Group, Department, Faculty), Publication, Research Event (Workshop, Conference, Tele-conference, Invited Session), Place (Country, City, Virtual Place), Document (Image, Xml Doc), and Research Domain (Knowledge management, Natural Language Processing, Ontology Engineering, Software engineering, Artificial Intelligence, Network, SemanticWeb).
- SLOT BROWSER:** Shows a slot hierarchy for the selected 'Person' class. The 'accepted-in' slot is highlighted. The list includes slots like 'accepted_papers', 'Address', 'affiliated_to', 'author', 'belonging_faculty', 'belonging_university', 'ckc2007', 'ckc2007_Slot_20026', 'ckc2007_Slot_20027', 'colocated with', 'DocName', 'DTD', 'full name', 'has homepage', 'has research topic', 'has topic', 'homepage', 'Image type', 'is less general then', 'is more general then', 'is related to', 'is topic of', 'Located in', 'located in', 'locator', 'name', 'organized by', 'part of', 'rTopic', 'skin_color', and 'takes part in'.
- INSTANCE BROWSER:** Shows a list of instances for the 'Person' class. The instance 'John Doe' is highlighted. The list includes names like Aldo Gangemi, Alireza Tajary, Alla Zollers, amin badiehneshin, Andrea Marchetti, Andreas Hotho, Andrew Gibson, Beate Krause, Bertrand Sereno, Byron Kuo, Christian Morbidoni, Christoph Schmitz, ckc2007_Instance_20211, Deana Pennington, Debbie Richards, Domenico Gendarmi, Ehsan mirrezae, Elizabeth Sklar, Elke Michlmayr, Enrico Motta, Fabio Abbattista, Filippo Geraci, Filippo Lanubile, Gerd Stumme, Giovanni Tummarello, Greg Riccardi, Hana Shepherd, Harith Alani, Harry Halpin, hasan, Hector Garcia-Molina, Ivan Cantador, and John Doe.

Changes Tab



CKC2007 Protégé 3.3 beta (rmi://smi-protege.Stanford.EDU/CKC2007)

Java Applet Window

File Edit Project Window Help

Classes Slots Instances

CLASS BROWSER

For Project: ●

Class Hier

- :THING
- :SYSTEM-CLASS
- Organization
 - Research_institute
 - University
- Person
- Publication
- Topic
- Workshop

Superclasses

- :THING

CLASS EDITOR

For Class: ● Person (instance of :STANDARD-CLASS)

Name: Person

Documentation

Role: Concrete

Template Slots

Name	Cardinality	Type
homepage	single	String

Annotations

All (Ann. & Chg.) Discussion Threads Search Chat

Annotations Changes

Filter: By author... Go

Changes for Person

- Added template slot: homepage to: Person
- Created Class Person
- Added template slot: full-name to: Person
- (TestUser2 04/13/2007 10:13:27 PDT): Why did you add this here?

Annotation body

INSTANCE EDITOR

For Instance: ◆ Added template slot: homepage to: Person (instance of TemplateSI...)

Context: Added template slot: homepage to: Person

Author: abhita

Timestamp: ◆ 04/10/2007 11:46:41 PDT

ApplyTo: ◆ Person

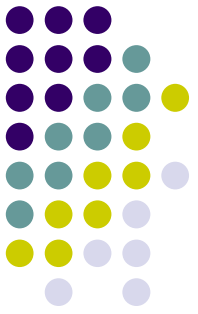
No other users

Changes

Change details

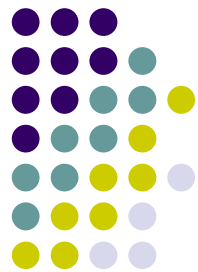
Annotations on changes

Changes Tab (cont)



- See the history of a concept
- Users may comment on changes; for example on a class rename operation or on a change of a domain property
- Browse the change details (e.g. author, creation date, sub-changes, etc.)

Discussion threads Tab



CKC2007 Protégé 3.3 beta (rmi://smi-protege.Stanford.EDU/CKC2007)

Java Applet Window

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Superclasses

- :THING

CLASS EDITOR

For Class: ● Person (instance of :STANDARD-CLASS)

Name: Person

Documentation:

Role: Concrete

Template Slots

Name	Cardinality	Type
homepage	single	String

Annotations

All (Ann. & Chg.) Discussion Threads Search Chat

Annotations Changes

Filter: By author... Go

Discussion Threads

Comment

- (natasha 04/13/2007 17:09:30 PDT): And probably add a more general superclass, like Ever
- (abhita 04/10/2007 12:02:43 PDT): We should use the URLs for papers from the main confe
- (TestUser2 04/13/2007 10:11:45 PDT): I agree

Annotation body

INSTANCE EDITOR

For Instance: ◆ (abhita 04/10/2007 12:02:43 PDT): We should use the URLs for pap...

Description

We should use the URLs for papers from the main conference page:
<http://www2007.org/workshop-W7.php>

Author: abhita Created: 04/10/2007 12:02:43 PDT

No other users

Generic discussion threads

Search Tab



CKC2007 Protégé 3.3 beta (rmi://smi-protege.Stanford.EDU/CKC2007)

Java Applet Window

File Edit Project Window Help

Classes Slots Instances

CLASS BROWSER

For Project: ●

Class Hier

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- :SYSTEM-CLASS
- Organization
 - Research_institute
 - University
- Person
- Publication
- Topic
- Workshop

CLASS EDITOR

For Class: ● Person (instance of :STANDARD-CLASS)

Name: Person

Documentation:

Role: Concrete

Template Slots

Name	Cardinality	Type
homepage	single	String

Annotations

All (Ann. & Chg.) Discussion Threads **Search** Chat

Annotations Changes

Search

Author: TestUser2

Annotation text:

Annotation type: Any type

Date: From: 04/16/2006 To: April 16, 2007

Condition: AND OR

Search

Search Results

- (TestUser2 04/13/2007 10:21:40 PDT): Why?
- ✓ (TestUser2 04/16/2007 16:14:24 PDT): Good idea!
- (TestUser2 04/13/2007 10:11:45 PDT): I agree
- (TestUser2 04/13/2007 10:13:27 PDT): Why did you add this here?

Annotation body

INSTANCE EDITOR

For Instance: ◆ (TestUser2 04/13/2007 10:13:27 PDT): Why did you add this here? ...

Description

Why did you add this here?

No other users

Search criteria

Search results

Chat Tab



CKC2007 Protégé 3.3 beta (rmi://smi-protege.Stanford.EDU/CKC2007)

Java Applet Window

File Edit Project Window Help

Classes Slots Instances

CLASS BROWSER

For Project: ●

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- Topic
- Workshop

Superclasses

- :THING

CLASS EDITOR

For Class: ● Person (instance of :STANDARD-CLASS)

Name: Person

Documentation:

Role: Concrete

Template Slots

Name	Cardinality	Type
homepage	single	String

Annotations

- All (Ann. & Chg.)
- Discussion Threads
- Search
- ! Chat**

Annotations Changes

Chat

- ◆ tania (Mon Apr 16 16:55:06 PDT 2007): Do you think it is a good idea to rename the Publication cl
- ◆ TestUser2 (Mon Apr 16 16:55:24 PDT 2007): Well...
- ◆ tania (Mon Apr 16 16:55:46 PDT 2007): What's the problem?
- ◆ TestUser2 (Mon Apr 16 16:56:09 PDT 2007): I think Publication is generic enough.

Annotation body

INSTANCE EDITOR

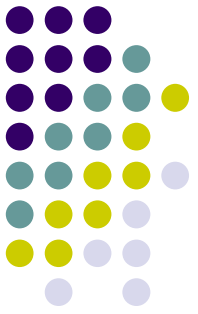
For Instance:

Other users: TestUser2

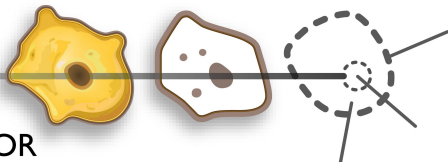
Chat messages

Online users

The National Center for Biomedical Ontology



- One of three National Centers for Biomedical Computing launched by NIH in 2005
- Collaboration of Stanford, Berkeley, Mayo, Buffalo, Victoria, UCSF, Oregon, and Cambridge
- Primary goal is to make ontologies accessible and usable
- Research will develop technologies for ontology dissemination, indexing, alignment, and peer review
- **BioPortal** - users may browse, search, visualize ontologies in a web-based portal



NATIONAL CENTER FOR

BIOMEDICAL ONTOLOGY

<http://www.bioontology.org/>

Marginal Notes in BioPortal

Ontology: Gene Ontology

Tree View

- Search: *intracell* GO!
- ROOT
 - id: obolnOwl:ObsoleteClass
 - molecular_function
 - cellular_component
 - cell part
 - virion part
 - synapse part
 - extracellular matrix part
 - protein complex
 - synapse
 - virion
 - extracellular region part
 - organelle
 - non-membrane-bound organelle
 - intracellular organelle**
 - membrane-bound organelle
 - extracellular organelle
 - vesicle
 - membrane-enclosed lumen
 - organelle part
 - extracellular matrix
 - envelope
 - cell
 - extracellular region
 - biological_process
 - rhamnogalacturonan I biosynthetic process
 - modulation by organism of entry into other orga

Class/Type Details

General
Class: intracellular organelle
Id: GO:0043229

Attributes
OBONamespace: cellular_component

Definition
Organized structure of distinctive morphology and function, occurring within the cell. Includes the nucleus, mitochondria, plastids, vacuoles, vesicles, ribosomes and the cytoskeleton. Excludes the plasma membrane.

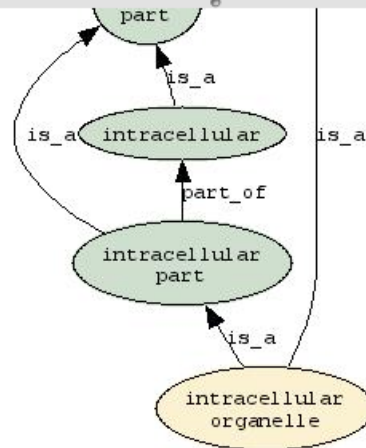
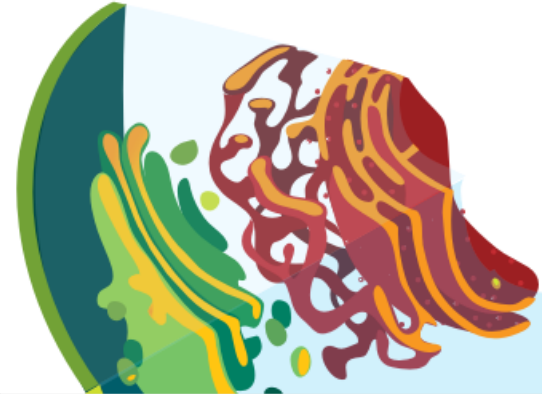
inSubset
Prokaryotic GO subset

Marginal Notes

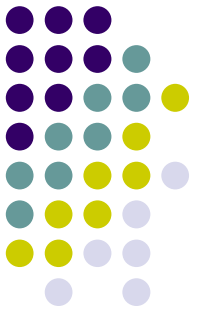
Add Note Add Reply Edit Note

Endoplasmic reticulum
Author: Dilvan Moreira Date: 10/03/2007 13:57:05 PDT
Subject: Endoplasmic reticulum

Endoplasmic reticulum and Golgi apparatus in [Wikipedia](#):



Outline

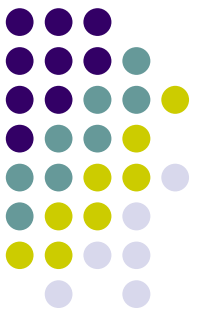


- Introduction and Background
- Tools for collaborative knowledge development
- Use cases
- Workflows
- Collaborative Protégé
- **Future directions**

Future directions

- short term -

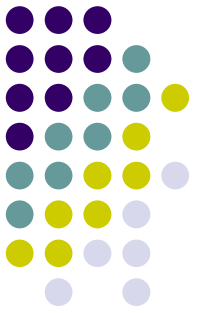
- Provide better modularization of the Changes and Annotations API
- Plugin architecture – other developers may add their own collaborative tabs
- Make the UI configurable: for example, see only the annotations and the search tab
- Chat with hyperlinks to ontology concepts
- Easier setting up of the collaborative features
- Optimizations with respect to performance and scalability



Future directions (cont)

- longer term -

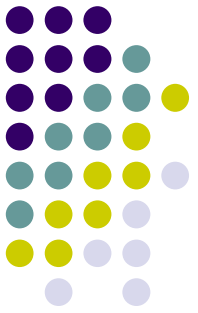
- Support for different workflow models
- Porting the collaborative components to Protégé 4
- Integrate into WebProtege



Feedback welcome!

tudorache@stanford.edu

References



[1] Collaboration: <http://collab.blueoxen.net/cgi-bin/wiki.pl?Collaboration>

[2] CKC Challenge: <http://km.aifb.uni-karlsruhe.de/ws/ckc2007/challenge.html>

[3] Tech Report with challenge results and discussions:

http://bmir.stanford.edu/publications/view.php/the_ckc_challenge_exploring_tools_for_collaborative_knowledge

CKC Challenge Tools:

[4] <http://www.bibsonomy.org/group/ckc2007>

[5] <http://protege.stanford.edu/doc/collab-protege/>

[6] <http://www.dbin.org/>

[7] <http://www.hozo.jp/>

[8] <http://soboleo.fzi.de:8080/webPortal/>

BioPortal:

[9] <http://www.bioontology.org/ncbo/faces/index.xhtml>